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(11) Publication number : **0 508 629 A2**

(12)

EUROPEAN PATENT APPLICATION

(21) Application number : **92302423.6**

(51) Int. Cl.⁵ : **C08J 5/12, B32B 25/08,
B32B 25/18, B32B 27/40,
H01R 4/64**

(22) Date of filing : **20.03.92**

(30) Priority : **22.03.91 US 673621**

(43) Date of publication of application :
14.10.92 Bulletin 92/42

(84) Designated Contracting States :
DE FR GB NL

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(54) **Bonding neoprene to polyurethane and electrical connector so made.**

(57) A neoprene body such as a plug boot (16) is secured to a polyurethane surface such as the jacket of an electrical connector, by etching the polyurethane surface, coating the etched surface (22) with a bonding agent, applying to the coated surface a neoprene film (24) and contacting the neoprene film with a quantity of neoprene (16) under suitable temperature and pressure.

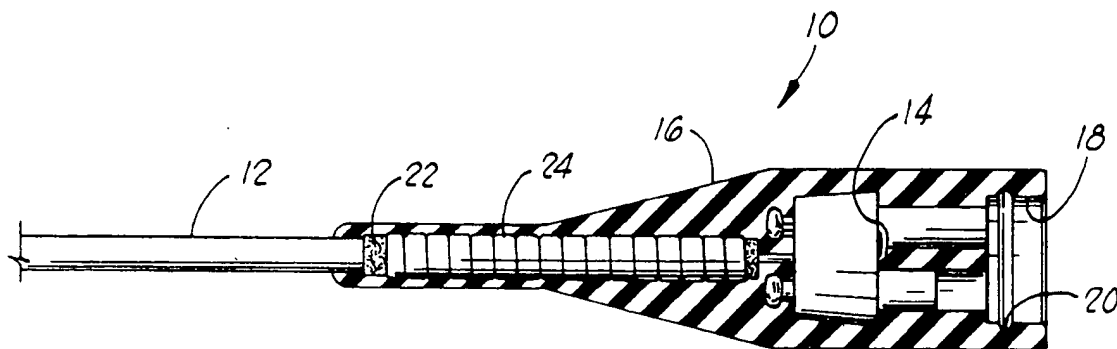


FIG. 3

EP 0 508 629 A2

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The present invention relates to a method of bonding neoprene to polyurethane, and to an electrical connector so made having a neoprene-based boot bonded to a polyurethane-jacketed electrical conduit.

Generally, in the process of acquiring seismic data, recording instruments responsive to ground motion are selectively positioned and coupled to the earth above the subterranean formation of interest. Seismic energy generated and transmitted into the earth imparts motion to the area of the earth proximal to origin of the seismic energy. In some instances, recording instruments responsive to motion generate a signal, generally in the form of voltage, proportional to ground motion.

Collecting and processing these signals requires electrically connecting, via electrical conduits, the recording instruments to seismic processing equipment. From time to time, it is desirable to selectively connect and disconnect the recording instruments from the electrical conduits during seismic data acquisition. In these instances, plug connectors having environmental seals, referred to as "plug boots", secured to robustly insulated electrical conduits are used.

Polyurethane is a common elastomeric material used in manufacturing such plug boots and conduits. Generally, the polyurethane plug boot is formed continuously with a polyurethane-jacketed electrical cable. The extending end of the plug boot is generally provided with a continuous lip for oversealing engagement with a mating plug.

Under mild temperatures, the polyurethane lip provides an adequate environmental seal at the union of the two plugs. However, at extreme temperatures (from about -55°C up to about 80°C), the polyurethane boot may stiffen when exposed to frigid temperatures, or become overly pliable when exposed to warmer temperatures. Additionally, the coefficient of compression of polyurethane is such that after repetitive engagements, the polyurethane lip may cease to adequately overseal with the mating plug. "Memory loss" is a term commonly used to describe the failure of the polyurethane lip to provide such overseal after repetitive engagements.

Another elastomeric material used in the manufacture of plug boots and conduits is neoprene. Generally, neoprene boots provide an adequate environmental seal over a wider temperature range than thermoplastics, including polyurethane, and also exhibit superior "memory" after repetitive engagements. However, neoprene jacketed cables have been found to be less robust than polyurethane-jacketed cables. Thus there exist the need for an electrical conduit and a reliable method of making the same that combines the superior sealing ability of neoprene and the superior robust qualities polyurethane.

We have now found a way of making such an article.

According to the present invention, there is provided a method of bonding a neoprene body to a urethane surface, which method comprises

- (a) etching the urethane surface;
- (b) coating the etched surface with a bonding agent;
- (c) applying a neoprene film to the coated surface; and
- (d) contacting the neoprene film with a quantity of neoprene under suitable temperature and pressure to bond it to the film.

The invention also provides an electrical connector comprising a urethane-jacketed electrical conduit; a plug, electrically connected to the electrical conduit; and a neoprene boot sealingly secured to the electrical plug and to portions of the urethane-jacketed electrical conduit adjacent the electrical plug.

In order that the invention may be more fully understood, embodiments thereof will now be described by way of example only, with reference to the accompanying drawings, wherein:

Fig. 1 is a plan view of an electrical conduit and an electrical plug connected at an end thereof. Etched portions of the conduit adjacent the electrical plug are also illustrated.

Fig. 2 is similar to the view of Fig. 1 further illustrating a neoprene film applied to a portion of the etched surface of the electrical conduit.

Fig. 3 is a cross-sectional view of a connector of the present invention.

Referring to Figs. 1-3, and with particular attention to Fig. 3, a connector 10 of the present invention includes a jacketed electrical conduit 12 and an electrical plug 14 connected to an end of the electrical conduit 12 in a conventional manner. A boot 16 is secured, such as by bonding, to the electrical plug 14 and to portions of the jacketed electrical conduit 12 adjacent the electrical plug 14. The boot 16 is preferably formed and secured to the conduit 12 by injection molding as discussed in greater detail below.

The boot 16 includes a continuous lip 18 for over-sealing engagement with a mating plug (not shown). Portions of the continuous lip 18 define a continuous groove 20 for detenting engagement with structure of a mating plug or adapter (not shown).

The jacket of the jacketed electrical conduit 12 is preferably constructed of an elastomeric based material and more preferably of a thermoplastic based material and still more preferably of a urethane based material and most preferably of a polyurethane based material. The jacket material of the jacketed electrical conduit 12 preferably includes a heat stabilizing additive. One such suitable jacketed electrical conduit 12 constructed of polyurethane and containing a heat stabilizing additive is BASF 1185A, a product of BASF Corporation, Michigan. The boot 16 is preferably constructed of a neoprene based material and more preferably of uncured neoprene.

Referring now to Fig. 1, in accordance with the present invention, the method of bonding a neoprene body to a polyurethane surface, and more particularly, the method of bonding a neoprene body to a polyurethane-jacketed electrical conduit and an electrical plug connected to the polyurethane-jacketed cable is performed by securing the electrical plug 14 to an end of the jacketed electrical conduit 12. The electrical connections between the conduit 12 and the plug 14 are made in the conventional manner.

Then a length of the jacketed surface of conduit 12 adjacent the plug 14 is etched and cleaned. The polyurethane surface may be etched chemically or mechanically but preferably by mechanical sanding. The etched surface 22 and plug 14 may be cleaned by swabbing with a cleaning solution, and more preferably with a solution of tetrahydroflurine (THF). A portion of the conduit 12, including the plug 14 and a short length portion, preferably .125 inches (3.2mm), of the etched surface immediately adjacent the plug 14, are coated with a first bonding agent (not shown), preferably a non-conductive bonding agent. The first bonding agent is preferably a vulcanizing metal primer. A suitable first bonding agent is THIXON P-6-1, a product of Whittaker Co., Ohio. After allowing the applied first bonding agent sufficient time to dry, preferably 4 to 6 hours, the non-coated etched surface 14 may be swabbed with a THF solution.

The non-coated etched portion of surface 14 is coated with a second bonding agent (not shown). The second bonding agent may be conductive or non-conductive. One such suitable conductive bonding agent is CHEMLOK 250, a product of Lord Corporation, Pennsylvania. If THIXON is used as the first bonding agent and CHEMLOK 250 is used as the second bonding agent, the second bonding agent should not contact or be applied to the first bonding agent. Drying time for the second bonding agent is preferably 3 to 8 hours.

Referring now to Fig. 2, a neoprene based film 24, is applied to an area of the coated surfaces of the jacketed conduit 12. The composition of the film 24 is preferably uncured neoprene. The film 24 may be applied by several methods, such as spraying, painting, dipping or preferably wrapping about the coated polyurethane surface. The thickness of the film 24 is generally between 0.020 and 0.200 inches (0.51 and 5.08mm), and preferably between 0.020 and 0.060 inches (0.51 and 1.52mm).

After applying the film 24 to the jacketed conduit 12, the conduit is positioned in a suitable molding apparatus (not shown), such as CLIFTON 30T, a product of Clifton Fluid Power Machinery Inc., New Jersey, such that a neoprene based material, preferably uncured neoprene, introduced into said molding apparatus contacts and overlies the plug 14 and the film 24. Prior to introducing the neoprene material into the molding apparatus, the surfaces of the molding appa-

ratus contacted by the neoprene material may be coated with a sufficient quantity of a non-stick silicone solution, such as for example, CAMI 888, a release agent and lubricant, a product of Camie-Campbell Inc., St. Louis, MO. Preferably, the molding temperatures may range from about 245° to 265°F (118 to 129°C) and molding pressure may be approximately 65 psi (0.45 MPa). Curing time in the molding apparatus is approximately 25 minutes.

After removing the electrical connector 10 from the molding apparatus, the connector is preferably cured for an additional 12 hours at 195°F (92°C).

15 Claims

1. A method of bonding a neoprene body (16) to urethane surface (12), which method comprises
 - (a) etching the urethane surface (12);
 - (b) coating the etched surface (22) with a bonding agent;
 - (c) applying a neoprene film (24) to the coated surface; and
 - (d) contacting the neoprene film (24) with a quantity of neoprene (16) under suitable temperature and pressure to bond it to the film.
2. A method according to claim 1, wherein the neoprene film is between 0.020 and 0.200 inches (0.51 to 5.08mm) thick.
3. A method according to claim 1 or 2, wherein step (d) comprises placing the product of step (c) in a mold, and introducing said quantity of neoprene into the mold.
4. A method according to claim 1, 2 or 3, wherein the urethane surface includes a heat stabilizing additive.
5. A method according to any of claims 1 to 4, wherein the neoprene body is a boot and the urethane surface is the jacket of a cable.
6. An electrical connector (10) comprising a urethane-jacketed electrical conduit (12); a plug (14), electrically connected to the electrical conduit; and a neoprene boot (16) sealingly secured to the electrical plug (14) and to portions of the urethane-jacketed electrical conduit (12) adjacent the electrical plug.
7. A connector according to claim 6, wherein the neoprene boot (16) is sealingly secured to the electrical plug (14) and portions of the urethane-jacketed electrical conduit (12) by etching the surface of the urethane-jacketed electrical conduit, coating the plug with a first bonding agent, coat-

ing a portion of the etched surface (22) with second bonding agent, applying a neoprene film (24) to the coated etched surface and contacting said plug and said neoprene film with a quantity of neoprene (16) under suitable temperature and pressure.

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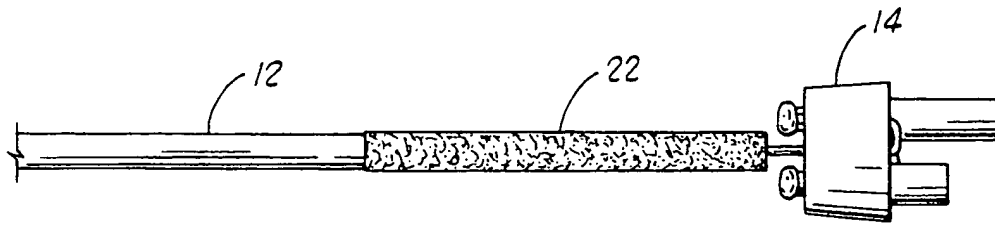


FIG. 1

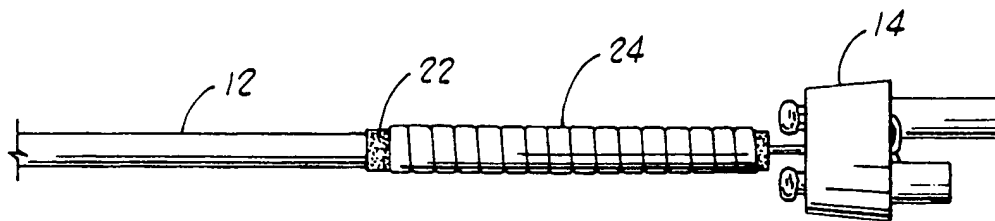


FIG. 2

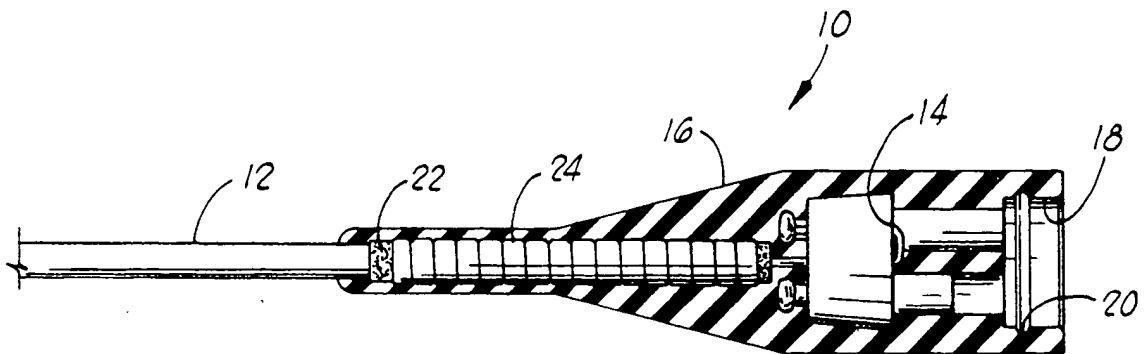


FIG. 3